Beam Pipe, Silicon Tracker, and VXD Mechanical Considerations

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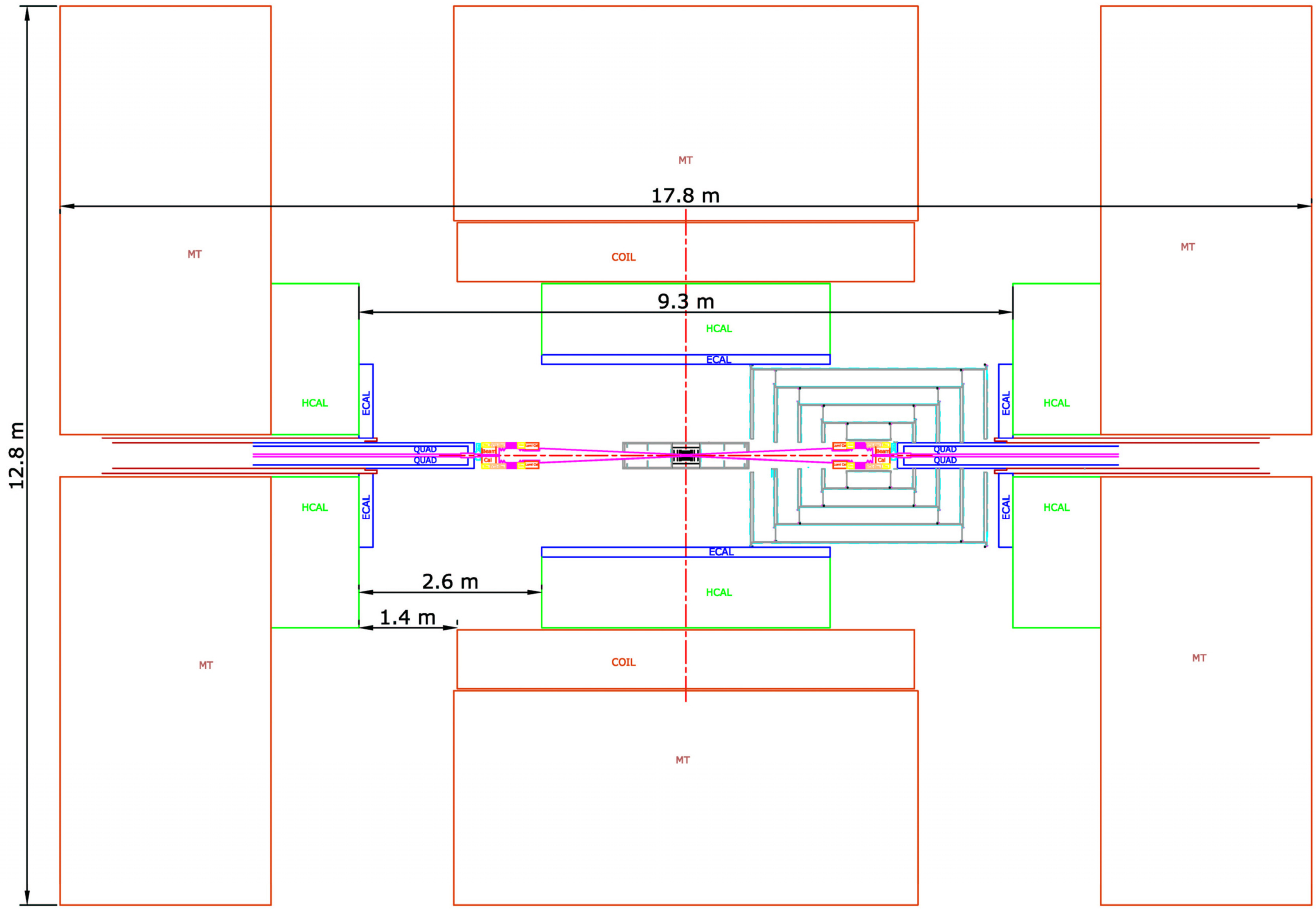
Summary of Issues

- The present SiD concept for servicing the VXD and associated small radius disks is to open the end-caps longitudinally and to roll the outer silicon tracker longitudinally.
- The beam pipe and beam line elements are assumed not to move.
- For optimal access, each end-cap should open at least 2.6 m from its normal, closed position.
  - That value could grow slightly.
  - Options requiring slightly less motion may be possible, but have disadvantages.
- Since beam line elements extend well within the outer silicon tracker during servicing, we would like to understand their transverse profile and the way in which they are supported.
- Beam pipe support, wall thickness and detailed shape, beam pipe deflections, and shielding integral with or associated with the beam pipe are also of interest.
- Operation of VXD at -90^o C appears to imply beam pipe bellows.
  - Where should they be?

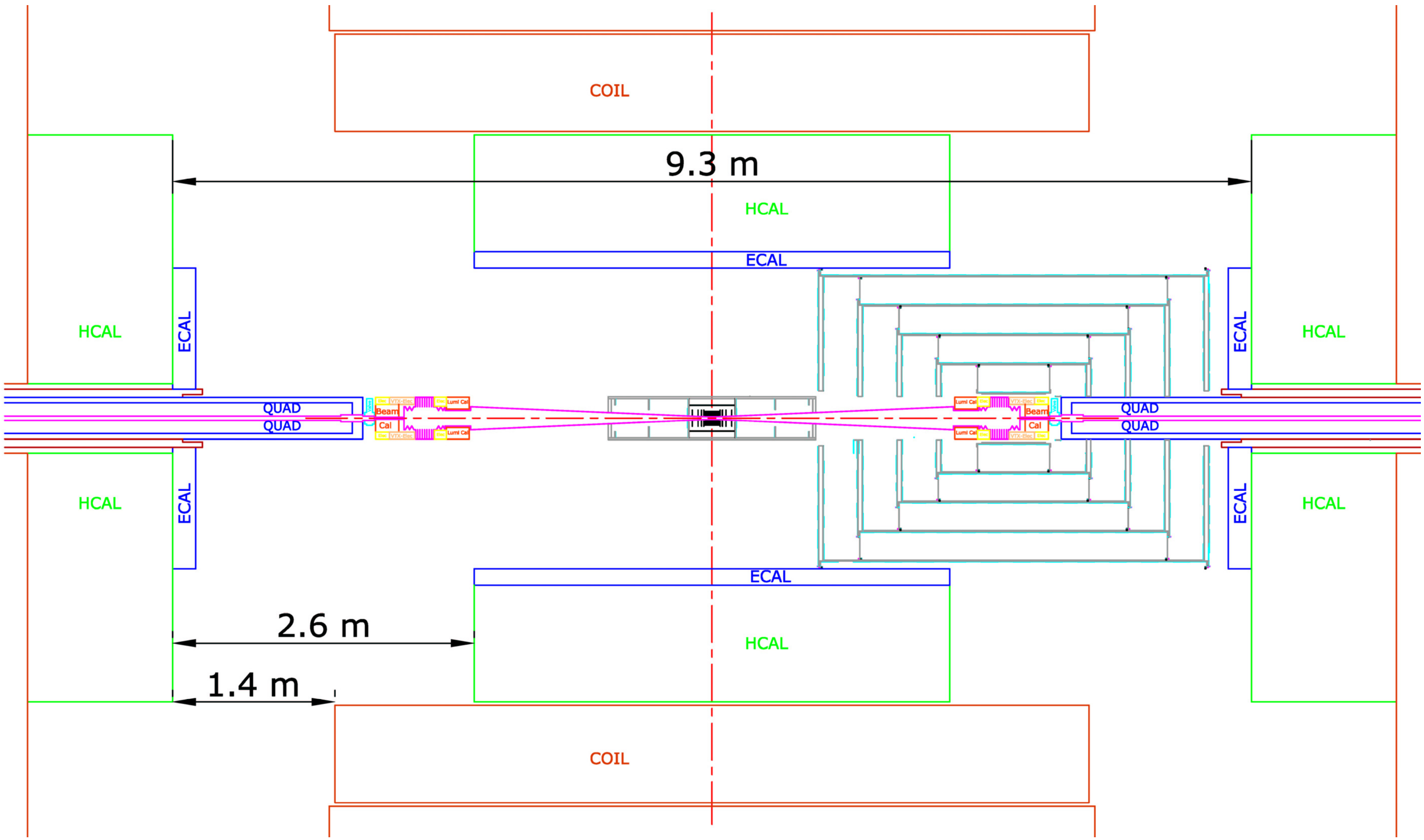
Caution

- Dimensions should be taken with a grain of salt.
  - Particularly for the calorimeters and muon system, they reflect early design concepts.
  - Beam delivery elements shown on sketches are clearly out of date.

Open Tracker with Full Access to VXD Elements



Open Tracker with Full Access to VXD Elements

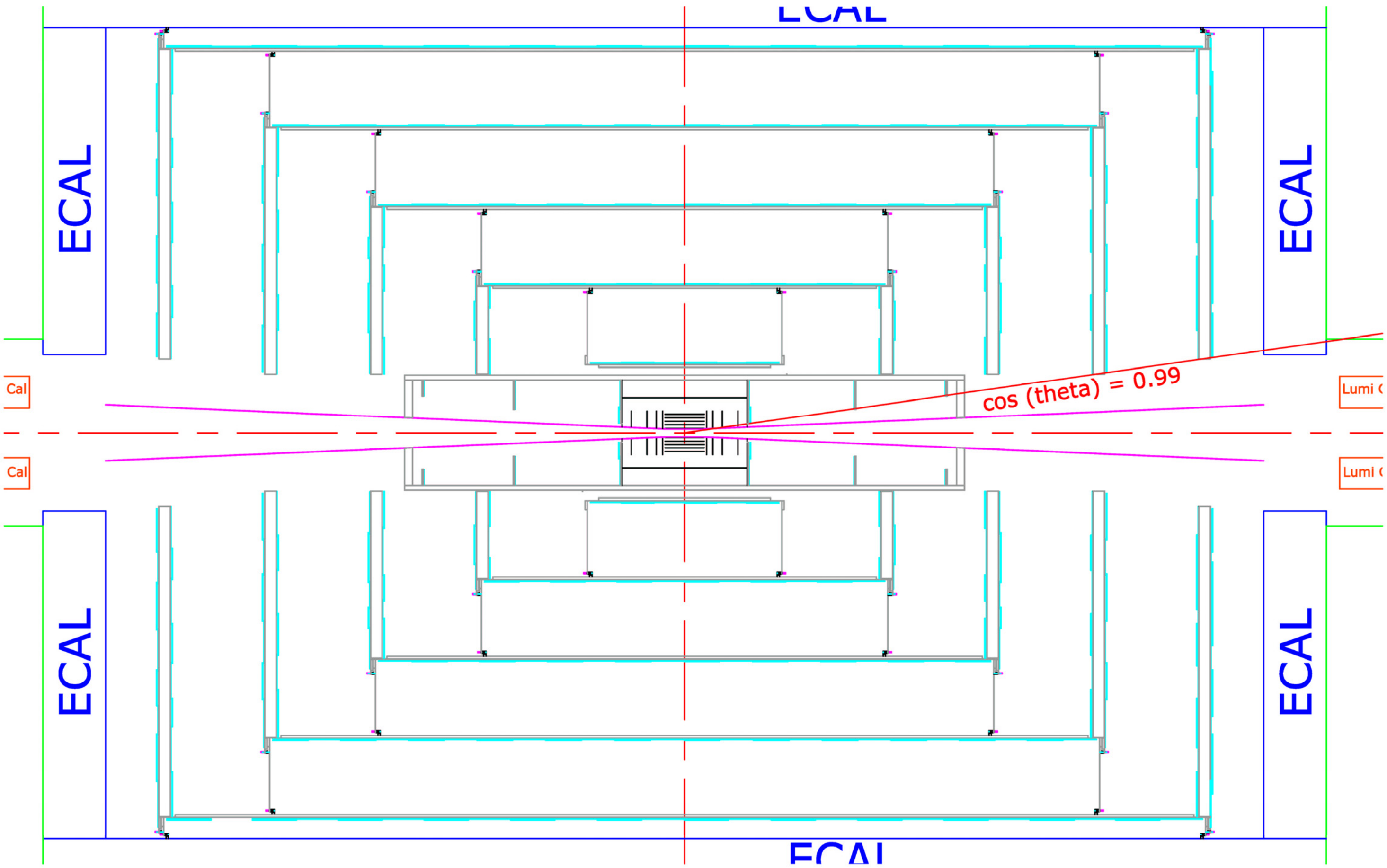


Comments Regarding Full Access

- Allows true half-cylinder sub-assemblies which include VXD and associated small radius disks
- Cantilever distance of beam line elements is greater than for other options, as is the required hall length.
- Greater longitudinal motion has implications for cable, optical fiber, and outer tracker rail support.
- Estimates of beam pipe deflections are shown later.
  - Given a limited knowledge of beam line details, deflections of beam line elements were assumed to be adequately represented by those of a longer beryllium beam pipe.
- Rolling support of the quads from the HCAL and end irons needs to be understood.
- Beam pipe bellows have been assumed to be located near the ends of the beam delivery system.

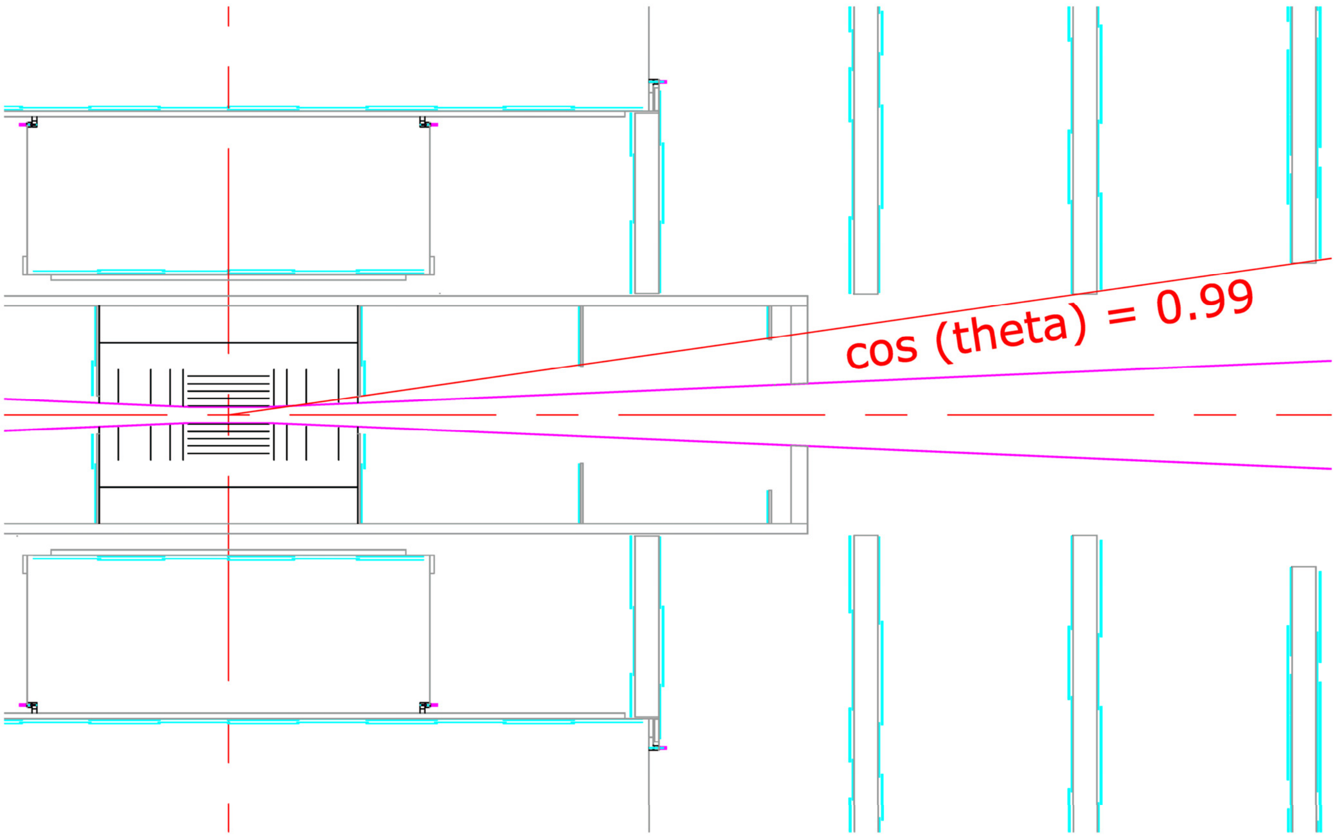
Concept of Inner Tracker (VXD) Support

- The previously discussed VXD plus disks beyond each end of it are shown supported within an insulating, double-walled cylinder.
- Note that the outer tracker geometry has not been updated.



Concept of Inner Tracker (VXD) Support

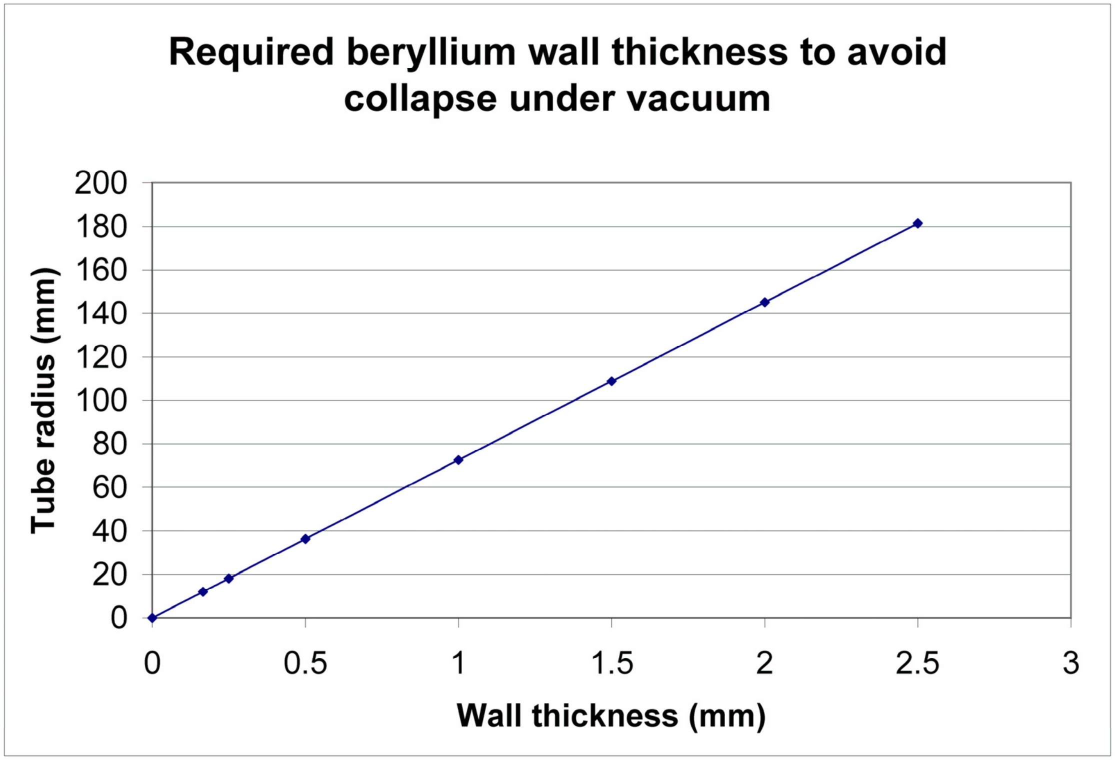
- The cylinder is coupled to the beam pipe at Z = ± 880 mm and Z = ± 200 mm.
- In addition to supporting detector elements, the cylinder aids in keeping the beam pipe straight.



Beam Tube

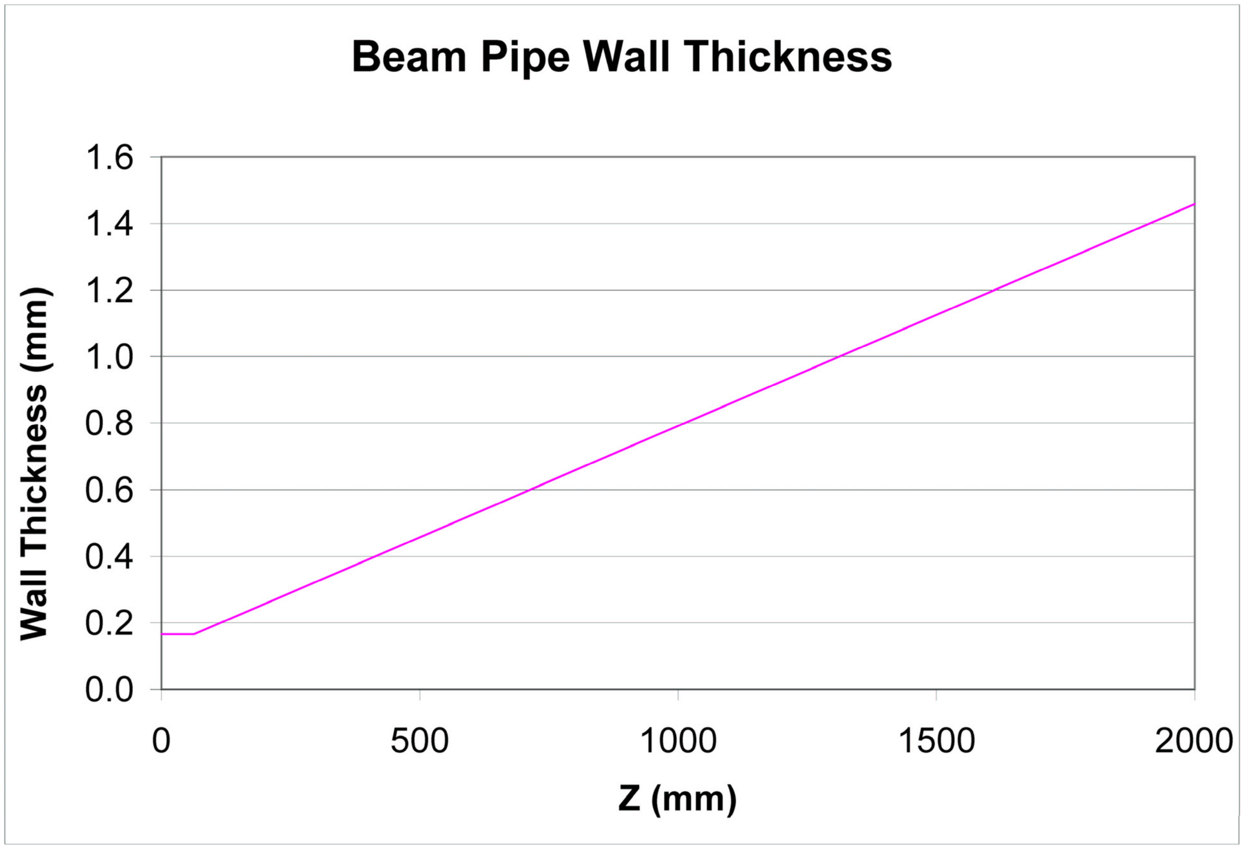
- Needed wall thickness was based upon an all beryllium, thin-walled beam pipe and standard Rourke and Young collapse calculations.
- The wall thickness to avoid collapse under 30 psid external pressure (a reasonable requirement for vacuum design) is shown below.
- R = 12 mm <—> t = 0.165 mm (a familiar number)

R varies linearly with t



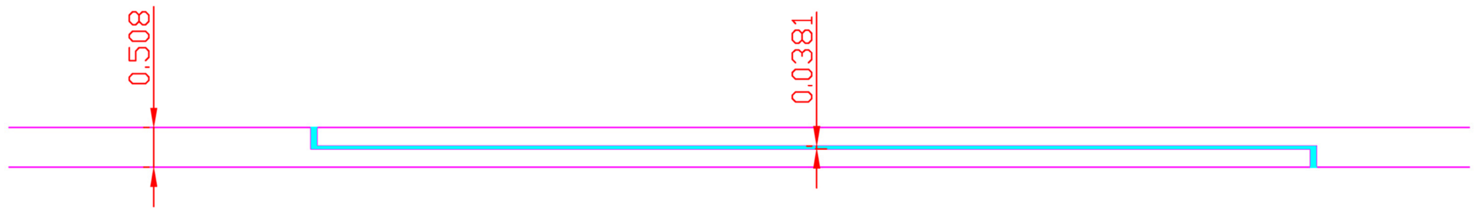
Beam Tube

- For a cone angle with dR/dZ = 17/351 starting at (R,Z) = (12 mm, 62.5 mm), the wall thickness to address vacuum is shown below. For SS, the wall thickness would increase by a factor of 1.145.

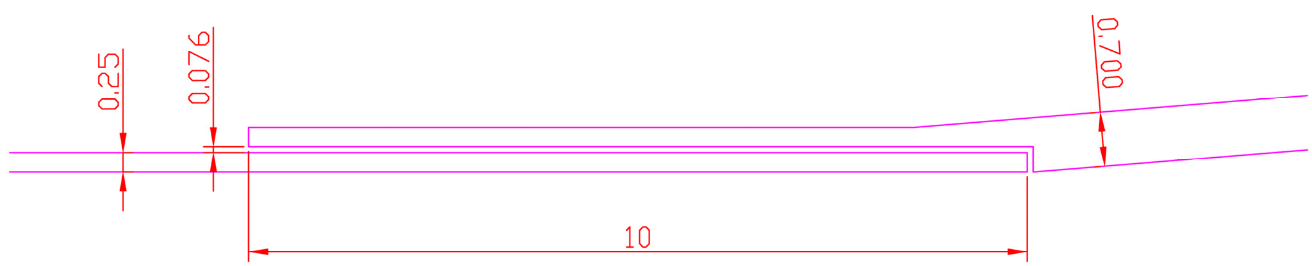


Beam Tube Joints

- Brush-Wellman Electrofusion developed a proprietary electron beam brazing technique for beryllium to beryllium joints. The braze material is thought to be aluminum.
- Joint concept for 1.16” OD (14.7 mm OR) DZero beam pipe:

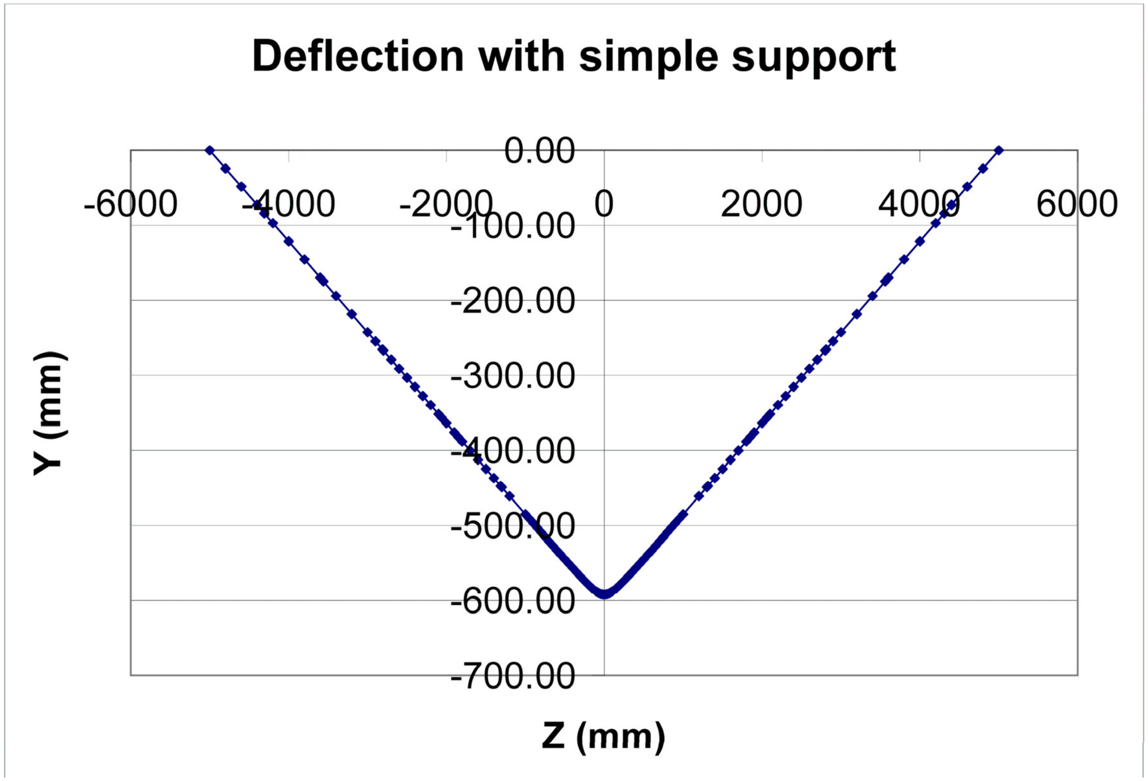


- Similar concept for ILC:



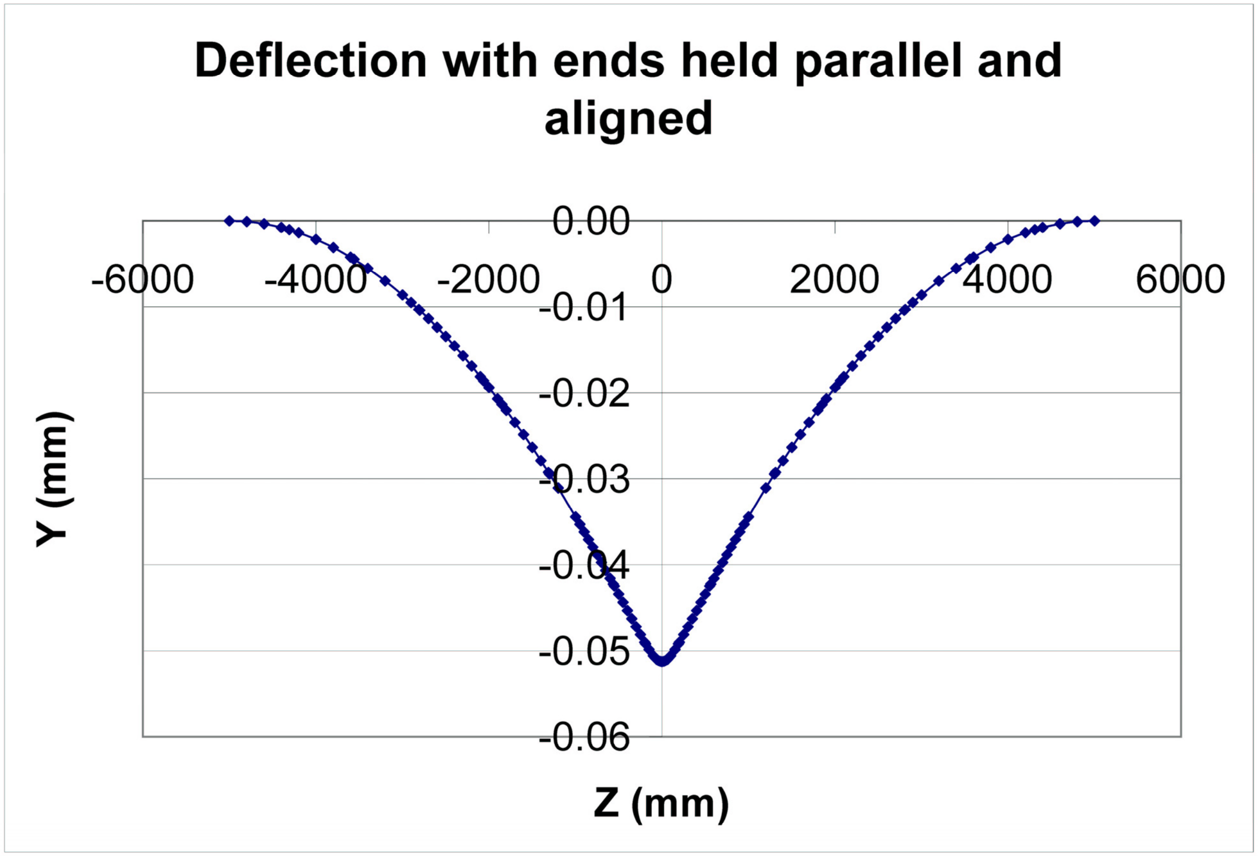
Beam Pipe Deflection (Preliminary)

- Wall thickness has been taken to be the minimum to avoid collapse.
  - We might learn later that that isn't sufficient.
- Weight of a 10 m (conservatively long) beam tube ≈ 34.7 Kg.
- Simple support from ends doesn't work.
- Stresses and deflections are unacceptable: 436 KSI and 590 mm.



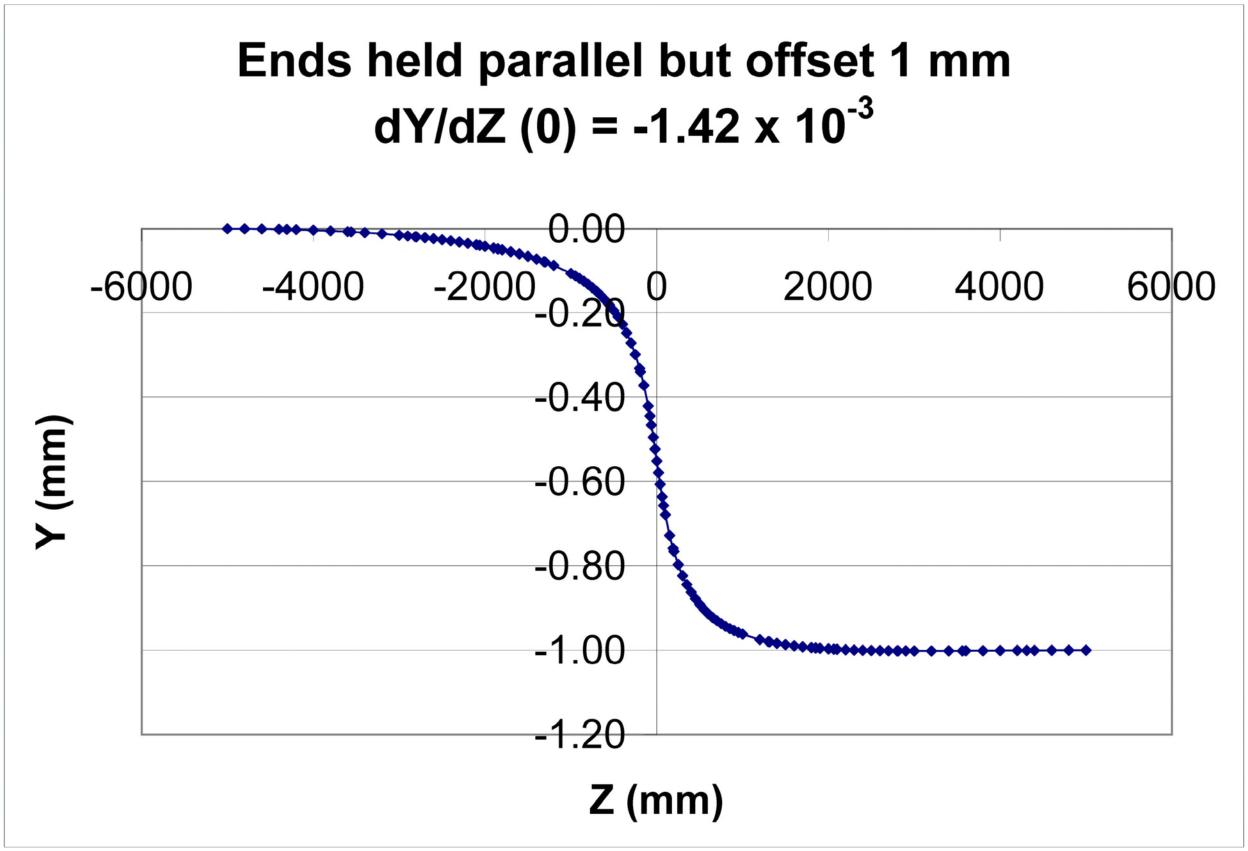
Beam Pipe Deflection (Preliminary)

- Deflection of the same beryllium beam pipe under its own weight with the ends held aligned
- Deflections and stresses are negligible.



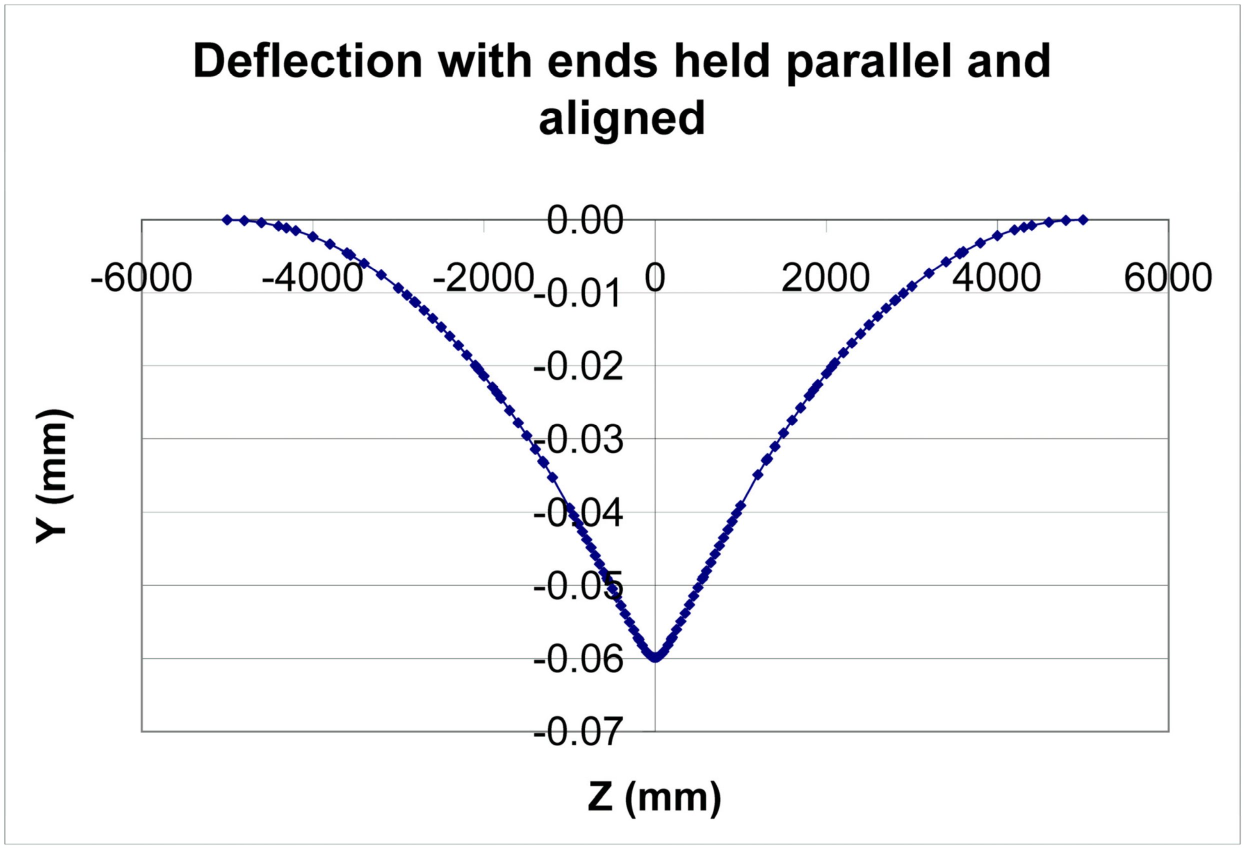
Beam Pipe Deflection (Preliminary)

- With ends reasonably guided, beam pipe stresses are OK.
- Maximum stress ≈ 2.9 KSI for a parallel offset of 1 mm.
- Braze joint stresses appear to be OK; need to check more carefully.

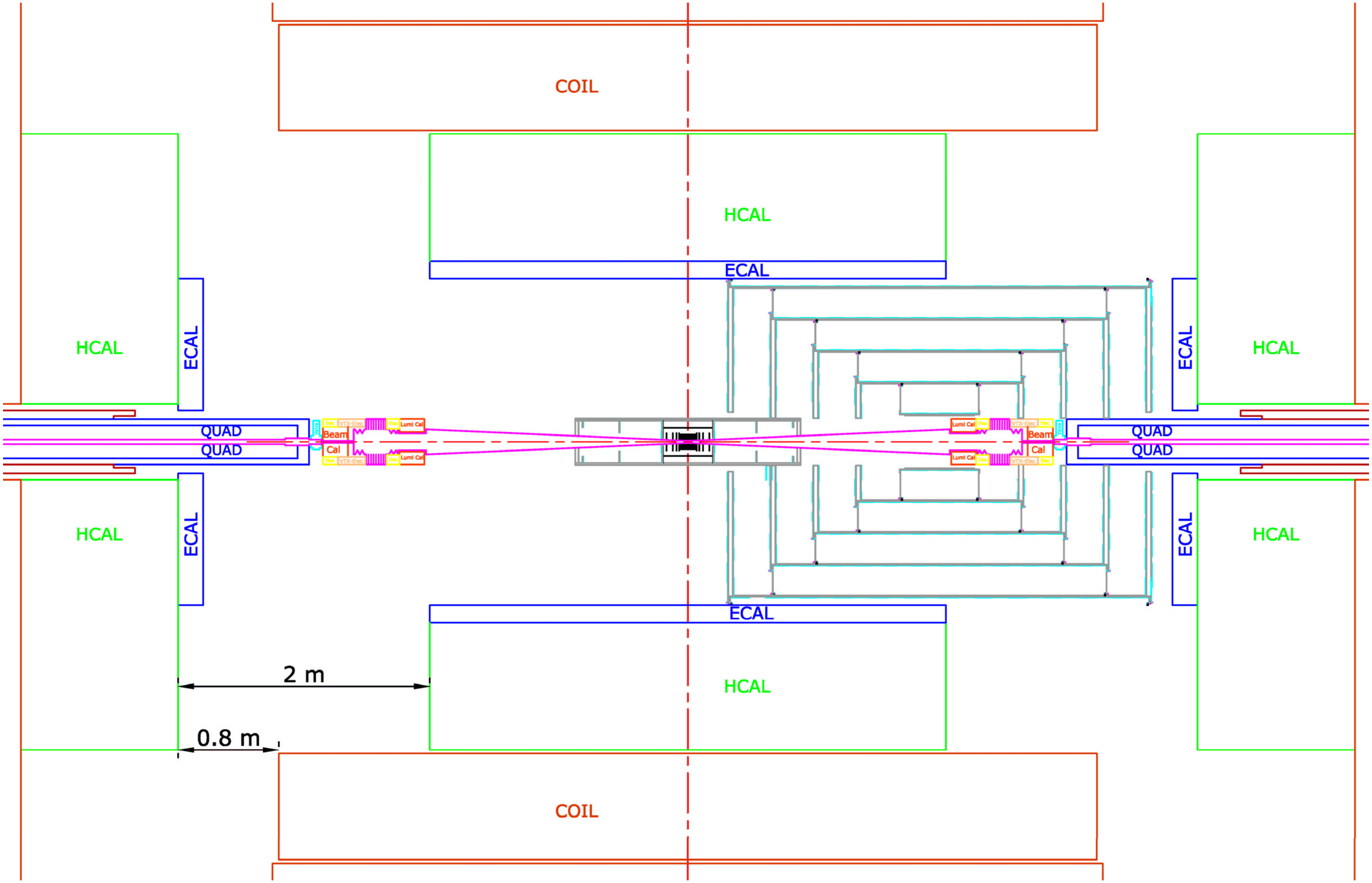


Beam Pipe Deflection (Preliminary)

- Deflection with additional symmetric loads of 250 grams at Z = ± 900 mm and beam pipe ends aligned.
- Additional deflection from the 250 gram loads is negligible (~8 μm).



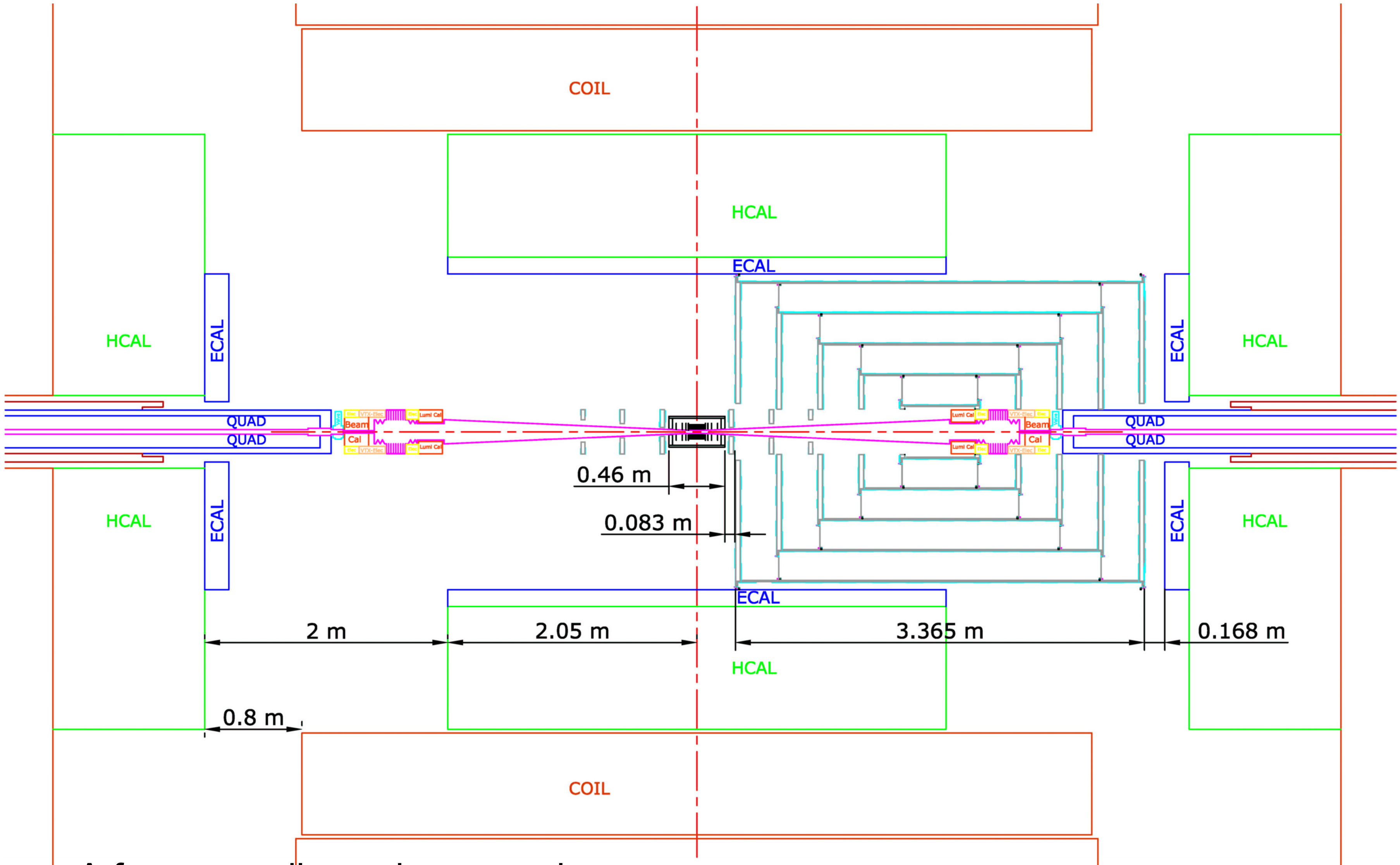
Option with Less Motion



Comments on this Option

- With end-cap motion limited to 2 m, it appears necessary to segment the VXD support in Z for servicing.
- That may not allow material to be used so efficiently, since VXD internal support replicates portions of the outer cylinder to beam pipe mechanical connections.
  - However, the four outer cylinder to beam pipe mechanical connections could consist of spokes, which represent relatively little material.
  - The amount of material in rings at the outer ends of spokes will need to be evaluated.

March 2005 Concept of an Open Tracker



A few more dimensions are shown.

Comments on the March Layout

- The minimal geometrically-required end cap motion to service the VXD (ignores forward, small-radius disks) is half the outer tracker length plus half the VXD length, or 1.91 m.
- Motion was rounded up to 2 m to allow a slight clearance.
- Forward, small radius disks were exposed only one end at a time.
  - The outer tracker would need to be moved the opposite direction to service the remaining small-radius disks.
- Support structure details for the VXD and small-radius disks were under study and were not shown.